

# Safe and Dynamic Driving towards Vision Zero

**SensePlanAct**

Chassis & Safety

**Continental** 



## Senses for Safety.

Driver assistance systems help save lives.

## MathWorks Automotive Conference 2015

Verkehrszzeichenerkennung in Fahrerassistenzsystemen  
– MATLAB @ Continental –



# Continental Corporation

## Five Strong Divisions

### Chassis & Safety

Vehicle Dynamics

Hydraulic  
Brake Systems

Passive Safety &  
Sensorics

Advanced Driver Assistance  
Systems (ADAS)

### Powertrain

Engine Systems

Transmission

Hybrid Electric  
Vehicle

Sensors &  
Actuators

Fuel &  
Exhaust Management

### Interior

Instrumentation &  
Driver HMI

Infotainment &  
Connectivity

Intelligent Transportation  
Systems

Body & Security

Commercial Vehicles &  
Aftermarket

### Tires

PLT,  
Original Equipment

PLT, Repl. Business,  
EMEA

PLT, Repl. Business,  
The Americas

PLT, Repl. Business,  
APAC

Commercial  
Vehicle Tires

Two Wheel Tires

### ContiTech

Air Spring Systems

Benecke-Kaliko  
Group

Compounding  
Technology

Conveyor Belt  
Group

Elastomer Coatings

Fluid Technology

Power Transmission  
Group

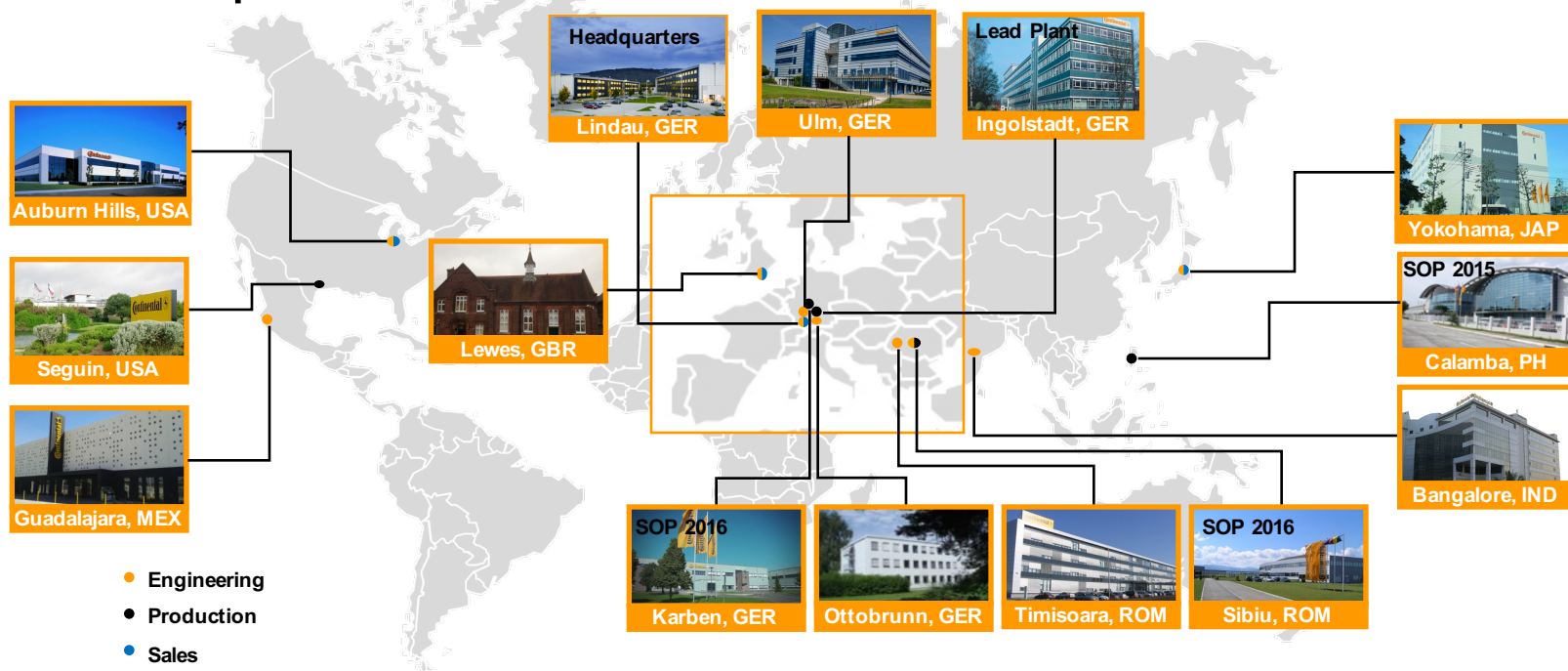
Vibration Control

PLT – Passenger and Light Truck Tires



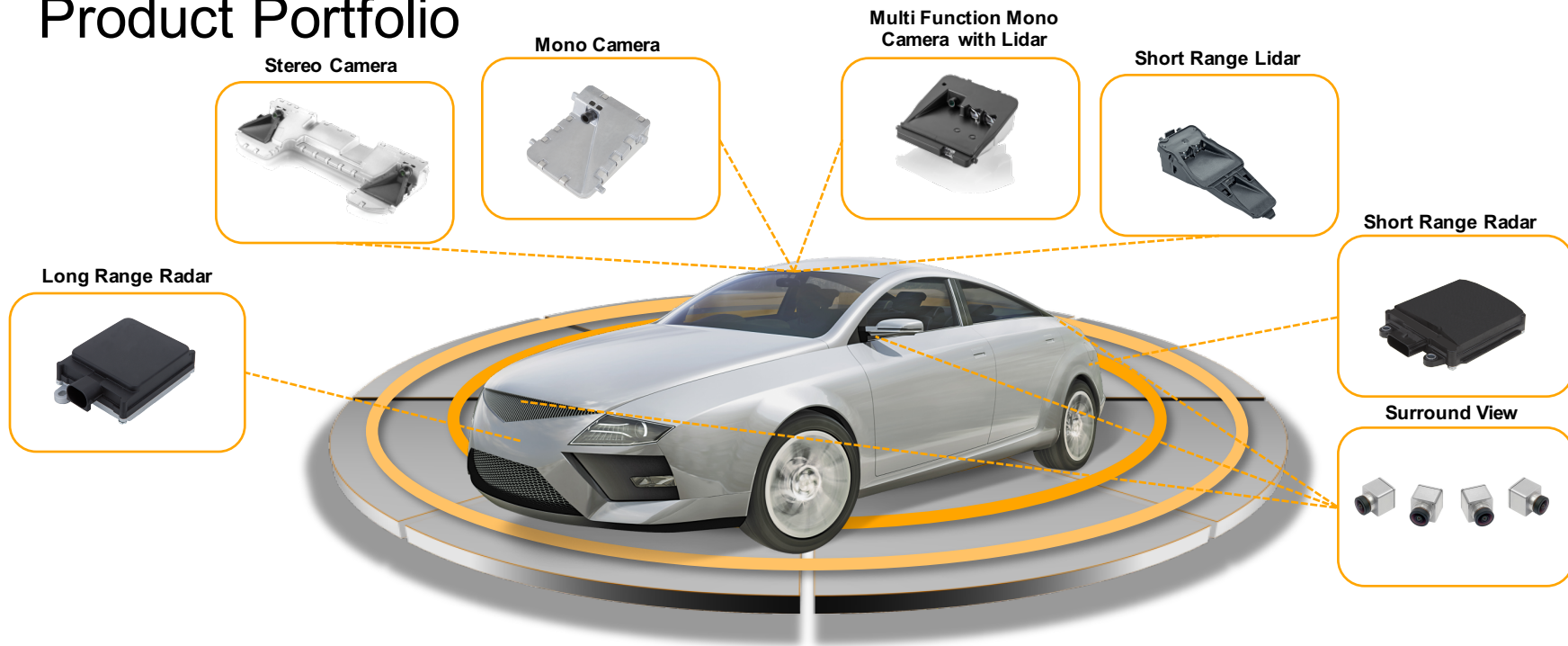
# ADAS Business Unit

## Global Footprint





# ADAS Product Portfolio



# ADAS Functions

## Overview & Motivation



Traffic Sign Assist



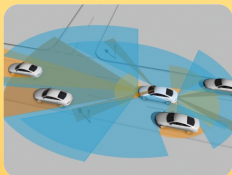
Emergency Brake Assist



Lane Departure Warning



Adaptive Cruise Control



Surround View



Blind Spot Detection



Intelligent Headlamp Control

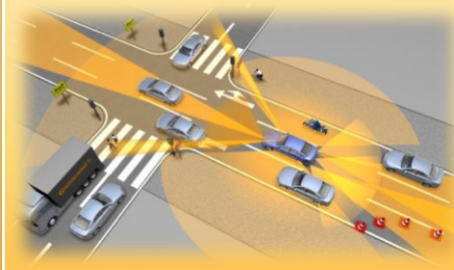


Rear Cross Traffic Alert

**“95% of all road accidents involve some human error, in 76% of the cases the human is solely to blame”**

**European Commission\***

**Increase safety & comfort is our mission!**

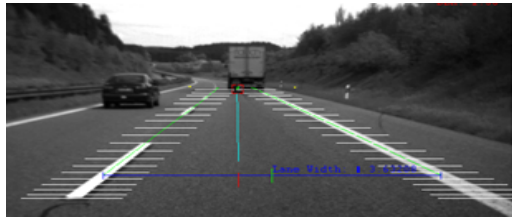


\* Directorate General Information Society and Media, Informal document No.: ITS-13-07

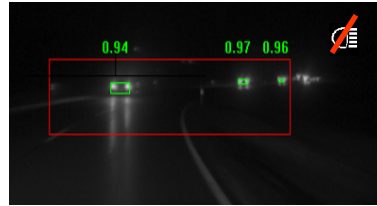


# Multi Function Mono Camera

One Camera for Multiple Functions



Lane Recognition



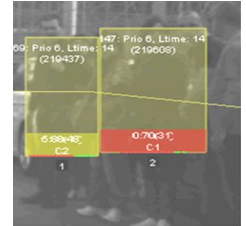
Light Sensing



Traffic Sign Recognition



Vehicle Detection



Pedestrian Detection

# Challenges – Getting confused?





# Challenges – Sign Set

› Recognized sign types with and without navigation input (with examples)

› Speed limits



› No-passing



› Directional / No Entry



› Stop / Yield



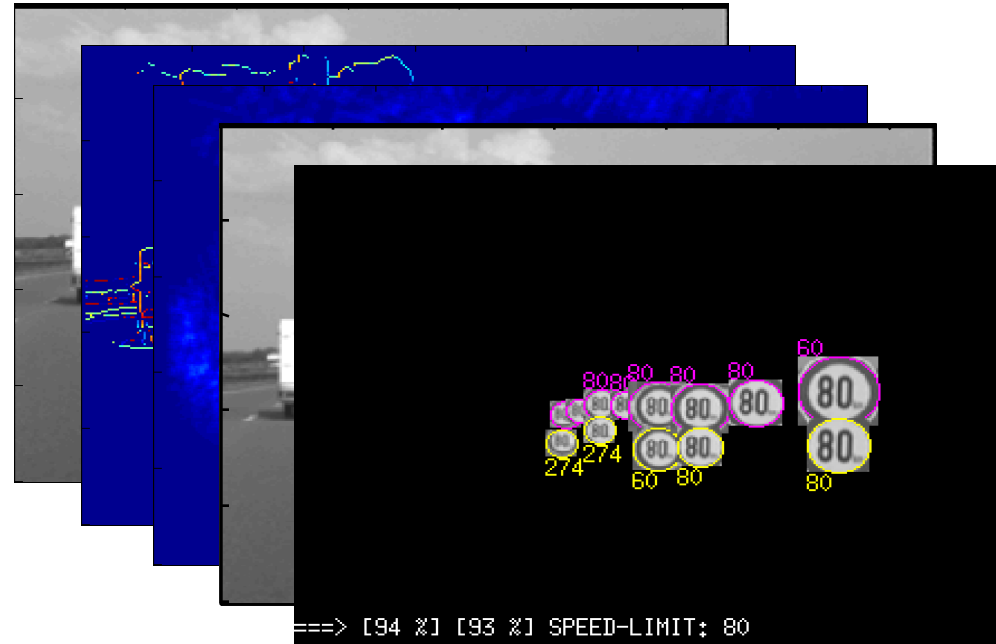
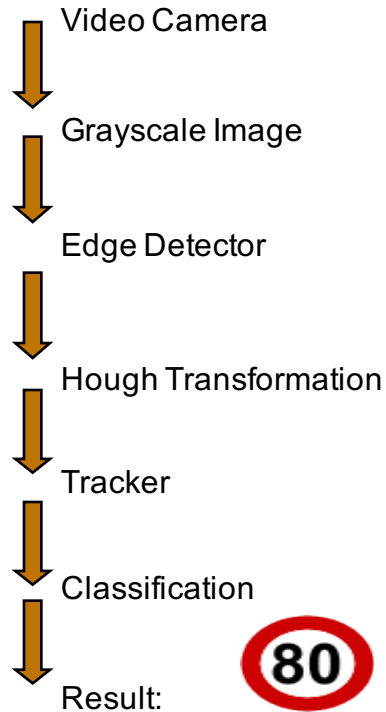
› Implicit



› Supplementary



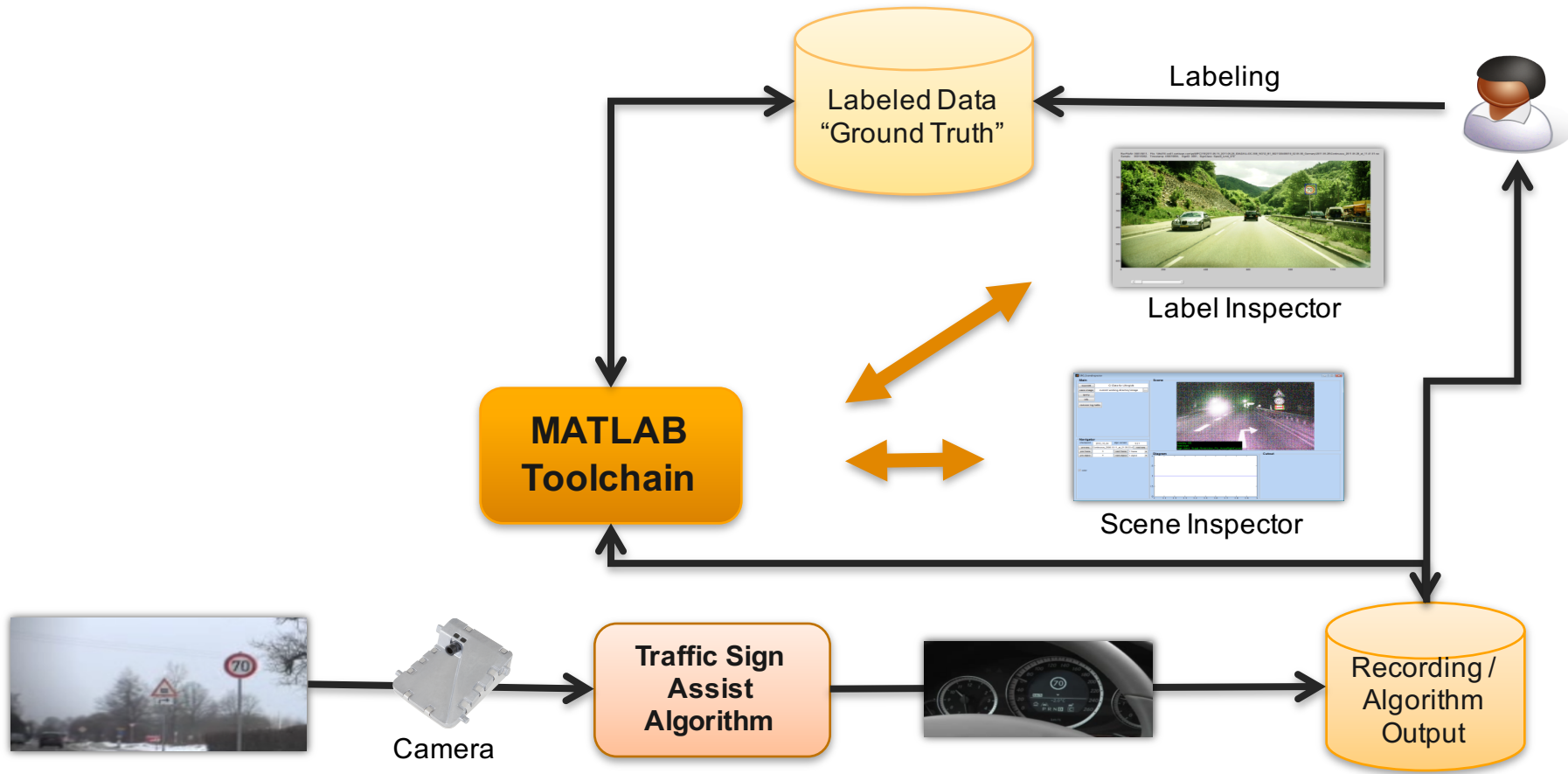
# Circular Sign Recognition Algorithm



# MATLAB Tooling

## Example: Traffic Sign Recognition - Classifier Training

- › MATLAB Tools are developed and used for
  - › Development / training, analysis, review, evaluation
  - › Interaction with different databases
- › Advantages
  - › Easy and fast pre-development
  - › Evaluation and generation of key performance indicators
  - › GUI and user friendly interfaces
- › Example: Classifier Training
  - › Training of classifiers for Traffic Sign Recognition is data driven
  - › Automated training
  - › Handling of large databases
  - › Evaluation and analysis





# Scene Inspector

The screenshot displays the SRG\_SceneInspector application interface. The main window is titled "SRG\_SceneInspector" and contains several panels:

- Main:** Contains buttons for "make query", "save image" (with a file path "D:\projects\SR\_SignRecognition\_..."), and "dump to console".
- Navigator:** Shows a "checkpoint" of "2013\_11\_29" and "algo version" of "10.7.2". Below this is a table of navigation options:

Continuous_2011.10.23_at_15.12.05.rec	1052745144		
pre seq	1/2	next seq	1 seq
pre object	1/4	next object	1 object
pre frame	68/94	next frame	1 frame
- Scene:** A large central window showing a highway scene with a bus on the left and several cars in the distance. Two speed limit signs (110) are visible on the right side of the road. A small text box in the bottom-left corner of the scene displays metadata:

```
country: PL  
road type: Motorway  
sign class: Speed_Limit_110  
sign id: 16  
partly: false  
invisible: None
```
- Eval:** Contains buttons for "load evaluation", "show selected", "new RLT entry" (with a dropdown menu "select request issues ..."), "reopen RLT entry", and "approve RLT entry".
- Statistic:** A panel for displaying statistics, currently empty.
- Cutout:** A panel with a "show cutout" checkbox and a grid of 20 circular cutouts. Each cutout shows a speed limit sign (110). Two cutouts in the top row are highlighted with red boxes.

At the bottom left of the application window, the status "Ready" is displayed.

# Scene Inspector



Cutout

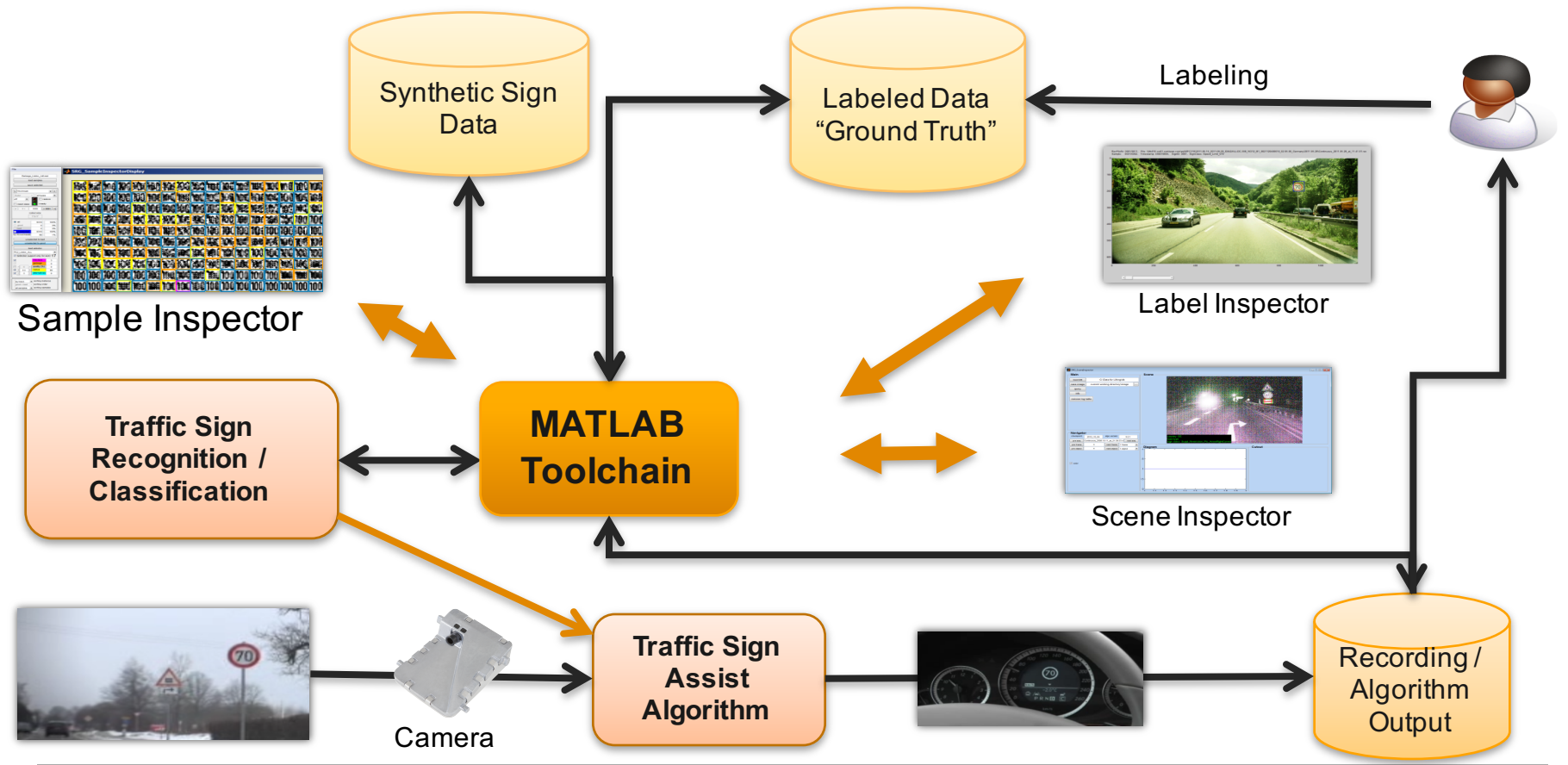
show cutout



Cutout

show cutout





# Sample Inspector

File

Garbage\_Liminn\_Lidl.mat

load samples

save selected

Garbage

Outer: all types

off

restore

reset class

>ready

1000

1001

cutout size: 17x17

<input checked="" type="radio"/> all	9318	100%
<input type="radio"/> good	0	0%
<input type="radio"/> bad	0	0%
<input checked="" type="radio"/> unselected	9318	100%
by PowerAssist	69	1%

unselected to bad

unselected to good

load selector

PC2\_Liminn\_ALL

selection support only for size: 17

<input checked="" type="checkbox"/> misclass	3
<input checked="" type="checkbox"/> garbage	0
<input type="checkbox"/> quality (%)	0
<input checked="" type="checkbox"/> radius	66
<input checked="" type="checkbox"/> alternatives	0

by track: sorting instance

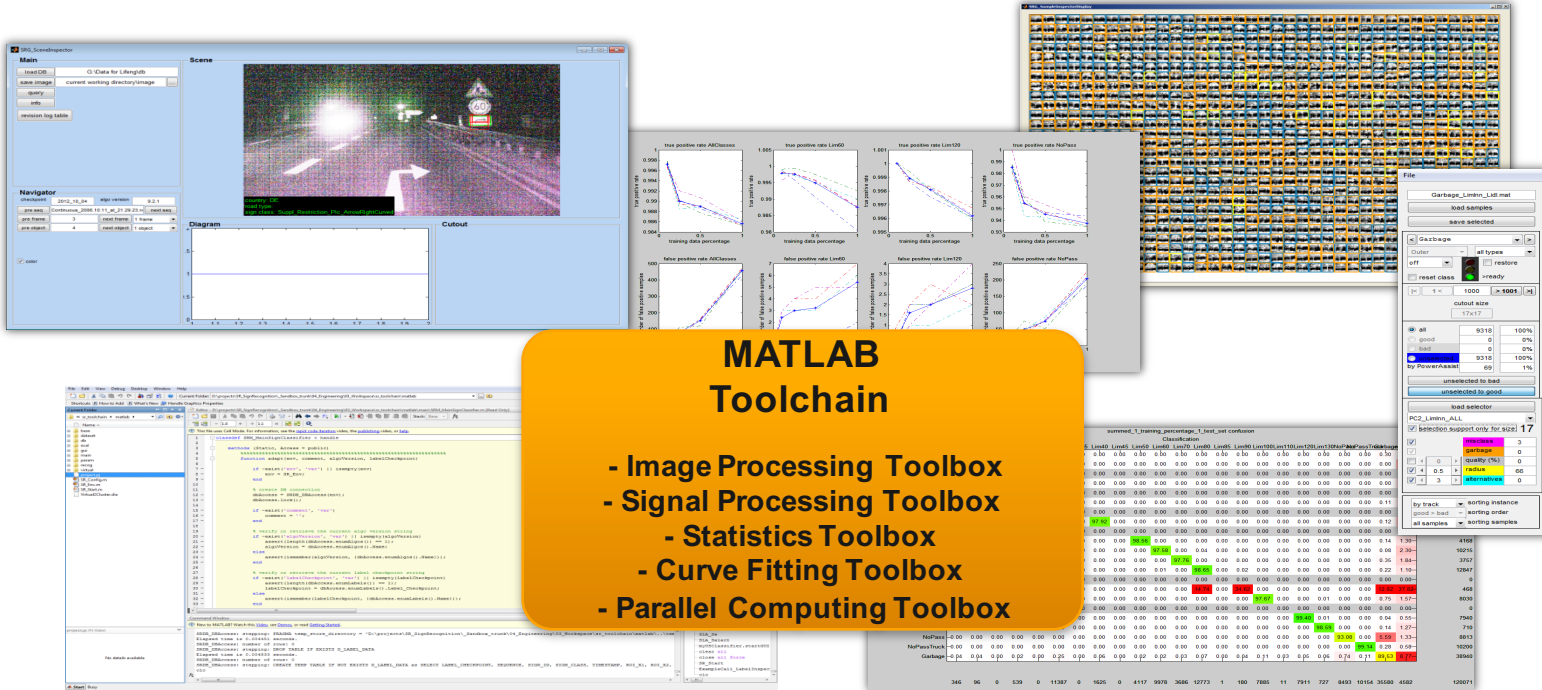
good > bad: sorting order

all samples: sorting samples

SRG\_SampleInspectorDisplay



# Evaluation



## MATLAB Toolchain

- Image Processing Toolbox
- Signal Processing Toolbox
- Statistics Toolbox
- Curve Fitting Toolbox
- Parallel Computing Toolbox

# Summary

- › MATLAB is used in daily work for development and evaluation of driver assistance functions
- › Prototypes are designed with MATLAB for predevelopment and proof of concept
- › Data management, evaluation, and interactive analysis are supported by MATLAB tools and GUIs
- › Traffic Sign Recognition and other functions make high use of MATLAB tools
- › MATLAB and its established features
  - › reduces our tool development efforts,
  - › accelerates our simulation cost,
  - › and allows reliable, repeatable and accurate parameter optimizations

**Thank you**  
for your attention!

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